

Description

[DIRECTION AND DISTANCE FINDER]

BACKGROUND OF INVENTION

[0001] Field of the Invention

[0002] The present invention relates to a direction and distance estimation system and method based upon characteristics of the power path loss curve.

[0003] Description of Related Art

[0004] Aircraft emergency locator systems such as ELTs (Emergency Locator Transmitters) and terrestrial location systems such as PLBs (Personal Locator Beacons) are well known in the existing art. Individuals lost at sea and fortunate enough to have emergency location identification devices such as an Emergency Position Indicating Radio Beacon (EPIRB), can send out RF signals with the hopes that their distress signals will be picked up by maritime stations or satellites, which can in turn, relay the information to the proper authorities.

[0005] Handheld or mobile location devices and systems can ef-

fectively locate the directional parameters associated with distress beacons; however, in order to obtain accurate distance readings, one must employ the use of satellites and global positioning systems (GPS). If a distress beacon emits a GPS signal to orbiting satellites, then a searcher may easily locate the distress beacon based upon the GPS reading. Many distress beacons currently being used are not equipped to transmit GPS readings and merely emit a RF signal for reception by a handheld, mobile, stationary or orbiting satellite receiver. As stated above, the RF receivers used to track and locate a RF signal from a distress beacon effectively locate the direction of the beacon, however reliable distance readings under this application are not possible. The lack of distance readings to the beacon can unnecessarily prolong or possibly imperil a search and rescue operation. If an individual is attempting to locate a person lost at sea, then initial movement of a search vessel is carefully monitored in order to prevent possibly running over the distressed victim. If the search vessel is a great distance from the distressed victim, then valuable time may be lost due to the necessity to move slowly during the searching process. If accurate distance readings were available, then the searching process could

be shortened and therefore increase the likelihood of a successful rescue.

- [0006] Directional and distance information may be equally important to search and rescue operations on land.

Searchers may need to locate a distress beacon in dense woods or an urban metropolitan area. The beacon may be used by hikers, off road adventurers, skiers, campers and children. If the searcher is limited to directional data only, then even the effectiveness of a land search could be significantly diminished.

- [0007] It would therefore be advantageous to provide a method and system for the location of a distress beacon that would provide the searcher with accurate distance and direction estimations. By providing a searcher with distance and directional estimations, the search time may be reduced significantly without endangering the distress victim. Although, the search and rescue operation has been discussed in association with sea and water rescue, distance estimations are also advantageous in regard to terrestrial search and rescue missions. It would also be advantageous if a handheld device facilitated the operation of the present system and method.

SUMMARY OF INVENTION

[0008] The present invention provides a system and method for locating the source of a RF signal. The present invention enables a user to locate the source of a RF signal as emitted by a distress beacon during a search and rescue operation. The present invention advantageously not only provides directional data as to the direction of the RF signal source, it also provides an estimated distance between a receiver and the RF signal source. A receiver according to the present invention advantageously provides direction and distance estimates based upon signal strength in a certain direction or over a certain distance.

[0009] In one exemplary embodiment of the present invention, a searcher using a signal locator (RF receiver) obtains the direction of the RF signal source, i.e., the distress beacon. The direction may be ascertained based upon signal strength readings taken by the locator where the strongest signal reading emits from the direction of the beacon. After obtaining the signal direction, the locator stores the initial RF signal strength reading and provides an estimated distance reading. The initial directional data and distance data provide an initial way point reading. The user may then proceed in the indicated direction and the locator produces continuous subsequent way point read-

ings. The subsequent distance readings may be determined based upon the path loss slope of the received RF signals. As the distance between the receiver and beacon decreases, the path loss slope dramatically increases. The path loss slope is the x-y graph of the beacon signal power strength as a function of distance from the receiver to the RF beacon. The present invention advantageously exploits this phenomenon in order to provide accurate and effective distance estimations.

- [0010] It is therefore an object of the present invention to provide a system that includes a signal locator where a graphical display resides on the signal locator. The graphical display provides the user with an initial way point reading that includes directional and distance data associated with the RF signal source. The directional and distance data is based upon the received RF signals. A processor within the locator receives, measures and stores RF peak signal strength of transmissions emitted by the RF signal source. The locator advantageously provides continuous subsequent way point readings for the user, where the subsequent way point readings include directional and distance data associated with the RF signal source. The distance data within the subsequent way

point readings may be based upon a path loss slope of the received RF signals.

- [0011] It is therefore another object of the present invention to provide a method for locating a RF signal source using a signal locator comprising the steps of: initiating a search mode for the signal locator; obtaining a direction for the RF signal source based upon a RF signal readings; moving a certain distance with respect to the direction of the signal and obtaining an initial waypoint reading, where the initial way point reading is based upon the rate of change of the RF signal strength as received by the signal locator; continuing to traverse with respect to the initial way point reading; and continuously obtaining subsequent way point readings based upon subsequent directional readings and subsequent distance readings, where the subsequent distance readings are based upon the rate of change of the RF signal strength as received by the signal locator.
- [0012] It is therefore another object of the present invention to provide a method for locating a RF signal source using a signal locator comprising the steps of: initiating a search using the signal locator; maneuvering the signal locator toward a plurality of compass directions in order to obtain a RF signal strength in the plurality of compass directions;

obtaining a direction for the RF signal source based upon a RF signal strength in the plurality of compass directions; providing an initial compass reading toward the signal source; advancing the signal locator in the direction of the initial compass reading; initiating a way point reading, based on the directional readings and distance readings, where the distance readings are based upon the rate of change of the RF signal as received by the signal locator; continuing to advance the signal locator; initiating a subsequent way point reading, based on subsequent directional readings and subsequent distance readings, where the subsequent distance readings are based upon the rate of change of the RF signal as received by the signal locator; continuing to advance the signal locator; and repeatedly initiating subsequent way point readings until the RF signal source is located.

- [0013] In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with particular reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

- [0014] Figure 1 shows a symbolic exemplary overview of a locating system according to the present invention.

- [0015] Figure 2 shows a top plan view of a locator (RF) receiver according to the present invention.
- [0016] Figure 3 shows a top plan view of the receiver shown in Figure 2 including an exemplary graphical display according to the present invention.
- [0017] Figure 4A shows a graph of RF signal strength path loss characteristics.
- [0018] Figure 4B shows a graph displaying exemplary slopes associated with a path loss curve according to the present invention.
- [0019] Figure 5A shows a flow chart describing a preferred locating method according to the present invention.
- [0020] Figure 5B shows a flow chart describing an alternate exemplary locating method according to the present invention.
- [0021] Figure 6 is a block diagram of the operation of the locator receiver to provide path loss slope data.
- [0022] Figure 7 is another exemplary application of the location system according to the present invention.

DETAILED DESCRIPTION

- [0023] The present invention provides a system and method that enables swift and accurate location of a RF signal source such as emitted by a distress beacon. The present inven-

tion advantageously uses path loss slope readings in order to eventually locate the RF signal source that is transmitted by the distress beacon. The present invention enables a user to acquire data with a handheld device and determine direction and distance of a RF signal source. The direction is determined based upon signal strength and the distance reading may be determined based upon power level changes that occur over the distance traveled, defined as power path loss slope.

- [0024] Referring now to Figure 1, a symbolic exemplary overview of a rescue directional locating system according to the present invention is shown. A RF transmitting beacon 120 floats on a body of water or is attached or held above the water by a person requiring location and rescue depicting a search and rescue situation. However, the present invention may be used in various other applications such as land based rescue missions and law enforcement applications, i.e. stolen vehicle recovery or fugitive apprehension. The beacon 120 preferably is attached to a person or object above the water surface and emits continuous RF signals 125 of a predetermined frequency. A RF signal locator 100 on vessel 10 receives the RF signal 125 and provides the user with way point readings to assist in the lo-

cation of the beacon 120.

[0025] Figure 2 shows the face of a locator, RF signal locator 100 according to the present invention. Antennas 101a-101d extend from the base of signal locator 100 in order to receive RF signals upon activation by the user. Figure 3 shows a graphical interface and control buttons associated with the signal locator 100. A power control button 106 activates the signal locator 100 for operation. Before initiating a search, the user sets the search frequency by using a channel frequency selector 104. The receiver may be set at any desired search frequency, although a number of the search and rescue missions involve locating beacons that transmit at 121.5 MHz. During operation a user may initiate a data acquisition by using an electrical switch represented as a search trigger 102. Although, trigger 102 is shown as a control switch button, the trigger may also be activated through the use of an actual trigger, not shown, on the underside of the signal locator 100. Another contemplated embodiment includes the signal locator 100 without any triggering mechanism, wherein the signal locator 100 upon activation continuously measures power changes in order to determine the path loss slope. A processor, not shown, within the re-

ceiver provides distance estimations based upon the path loss slopes.

- [0026] A graphical reading display (GRD) 110 provides a display of the real time data and output data processed during the search. A RF signal strength display 116a shows the signal strength reading numerically and graphically. A user pivots or rotates in a 360 degree direction while pointing the signal locator 100 outwardly toward different compass headings in order to initially locate the direction of the RF signal source. The RF signal strength display 116a displays the real time power levels, wherein the power level readings assist in determining the direction of the signal source. Above the RF signal strength 116a, compass 116b displays the direction that the signal locator 100 is pointing and changes accordingly upon movement. Below the signal strength display 116a, a search data display (SDD) 114 provides the user with specific data regarding the different search modes and the associated weighting of each mode.
- [0027] The signal locator 100 includes three search modes: power slope calculation, triangular vectors and data mapping. Each search mode is always active and uses global positioning system (GPS) data, direction data and power

level data to associate the resulting way points for each mode with an associated weight, i.e. confidence factor. The mode that is weighted the heaviest is displayed on the recommended mode way point section of the display using a standard GPS reading protocol. The SDD 114 displays the GPS reading for each search mode below the recommended mode way point and provides the weighting for each reading. The factors for processing which way point to use of the different modes are the distance traveled toward, away or perpendicular to the RF beacon signal and whether a directional antenna is being used.

- [0028] Below the SDD 114, a way point display (WPD) 112 provides the user with specific compass direction and distance information. The compass direction and distance information gives the user the estimated distance and direction of the RF signal beacon source. The distance and direction information may change as more data is acquired and processed, and consequently more accurate readings are produced as the user approaches the RF signal source.
- [0029] Referring now to Figure 4A, a graphical display of RF signal power v. distance is shown. Distance is measured between the RF beacon signal source and the locator, RF re-

ceiver. The graph of Figure 4A shows that as distance increases, the slope associated with the path loss curve decreases to substantially zero. When a larger distance separates the signal locator 100 and the RF signal source, the signal locator 100 displays a large distance number for the way point 112. Under most circumstances the accuracy of the way point reading at longer distances is not critical. The user simply knows at longer distances, one must simply traverse a substantial distance in order to locate the beacon. As the user continues the search toward the RF signal source and obtains more data, the receiver will read a greater slope change and appropriately provide the user with a smaller and more accurate way point reading closer to the distress signal. The present invention therefore allows the user to locate the RF signal source based upon the slope characteristics of the path loss curve. Referring to Figure 4B, slope readings A-F along the path loss curve are depicted. As the distance decreases, the slope readings increase A-F. Accordingly, a user receiving readings at two miles or greater clearly understands to generally proceed in the appropriate direction and that the RF signal source is a large distance away from the signal locator 100. Having a greater certainty

that the RF signal source is a substantial distance from the receiver, the user may move more swiftly without fear of over shooting the RF signal source. If the user is performing a water search and rescue, then the user does not need to fear possibly running into the RF signal source or the person in distress when receiving way point readings that represent longer distances. The distance readings based on the power slope enable users to more quickly pinpoint the RF signal source and more effectively perform a search and rescue.

- [0030] Figure 5A shows a flow chart describing the preferred method according to the present invention. A user first initiates the search mode on the signal locator 100, step 200. The user then OLE_LINK1maneuvers the signal locator 100, step 210, in order to pick up a directional indication, step 215. The user begins to advance in the direction as indicated, step 220OLE_LINK1. Next, the user manually engages the search trigger 102 (Figure 3) to search for a way point reading, step 225, and the locator 100 provides the way point reading, step 230. The user continues in the direction of the way point reading, step 235, and manually triggers a subsequent search for a more precise way point reading, step 240. The user continues to advance in the

direction of the way point/target, step 245, and repeats subsequent searches using trigger 102 until the RF signal source is found, step 250.

[0031] Figure 5B shows an alternative method according to the present invention. The user initiates a search, step 300. The user then maneuvers the signal locator 100, step 310, in order to pick up a directional indication, step 320. A processor in the signal locator automatically is preprogrammed to provide way points based on different variables such as signal strength and location. Next, the user begins to advance in the direction as indicated, step 330, while advancing the user receives continuous way point readings where the distance component is based on path loss slope 340. This exemplary method allows the user to continuously advance toward the way point/target, step 350, until the target is found, step 360. Both the methods of Figures 5A and 5B provide the user with increasingly accurate way point readings as the user progresses toward the RF signal source. Both methods use the path loss slope to quickly and efficiently locate the signal source and thus substantially minimize search time.

[0032] Referring now to Figure 6, the direction distance finding system contained inside the receiver is shown in the block

diagram. Beam directional antennas 602 are connected to a calibrated frequency modulation (FM) receiver 604 that receives the RF signal and determines the RF signal's strength. The receiver 604 filters any noise associated with the RF signal. The RF signal received from the beacon, which is a FM signal, is then sent to a signal processing unit 606. The signal processing unit 606 also receives data from a GPS receiver 610 and a compass 612. A battery 620, connected to the signal processing unit, provides power to the system. The signal processing unit 606 provides real-time data to the real-time compass, GPS and signal strength displays 614 for display on a readout display 625. The signal processing unit 606 also sends data to a data processor 608a, where the data processor 608a outputs predicted distance, direction and GPS coordinates based on the slope, triangulation or data mapping modes and the direction of the strongest signal strength where an associated weight for each mode 618 shows on the readout display 625. The data processor 608a functions based upon instructions from a memory unit 608 which also stores data received from the data processor 608a. Based on the information received by the signal processing unit 606, when the user activates a switch

such as a trigger, the signal processing unit 606 will provide the new waypoint readings in the embodiment that includes a trigger for use by the user. Sensitivity down to 113 decibels milliamps is typical for the handheld version. By using the signal processing unit 606 and the memory 608, the receiver can provide predicted distance readings based on relative signal strength as the user approaches the beacon.

- [0033] Referring now to Figure 7, another exemplary application of the present invention is shown. A monopole antenna 450 installed on a vehicle 440 receives RF signals 425 emitted by a source beacon 420. A user in the vehicle 440 initiates a search for the beacon 420 by traveling over a certain area. A signal locator display, not shown, provides information to the user regarding the reception received by the antenna 450. Figure 7 shows two exemplary paths that may be traversed by the vehicle 440 in order to locate the beacon 420. Based upon the operator of the signal locator and the route available to the user, either path #1 or path #2 may be traversed in order to locate the beacon 420. Regardless of the route endeavored by the user, the signal locator consistently enables the user to locate beacon 420. Different resultant paths may be traversed due

to the terrain, buildings and atmospheric conditions, all of which may affect the received signal. The signal locator obtains initial signal strength and displays a waypoint based upon subsequent strength readings of the received RF signal over a certain area. The signal locator continuously receives RF signals and generates subsequent way point readings based on the received RF signal. The subsequent way point readings guide the user to the beacon 420 and allow the user flexibility in traversing toward the beacon 420 based upon terrain and environmental conditions.

- [0034] The instant invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. It is recognized, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art.